Applicant(s): Eitan Bachmat, Tao Kai Lam and Ruben Michel
Serial No.: 09/541,159
Filed: March 31, 2000

E30-043 (99-202)

REMARKS

This application is pending with claims 1 through 28. The Examiner indicates claims 23 and 26 are allowed and that claims 7, 11 through 18, 24, 25, 27 and 28 are objected to. The Examiner rejects claims 1 through 6, 8 through 10 and 19 through 22. Claims 6, 10, 23 through 25, 27 and 28 are amended. Claims 1 through 28 remain in the application

Applicant requests reconsideration and reexamination of the above-identified application in view of the amendments made to the specification and claims. The following remarks state Applicant's bases for making this request and are organized according to the Examiner's Action by paragraph number.

Examiner's Action, Paragraph 1

The Examiner objects to the use of "United States Letters Patent" in the specification. Applicants prefer to leave this statutory language (35 U.S.C. §8) in the specification. This phrase distinguishes utility patents from design or plant patents. Applicants prefer the formal designation of a patent number. If however, the Examiner persists in the objection, Applicants will agree to the change.

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Examiner's Action, Paragraph 2

The Examiner objects to claims 6, 24, 25, 27 and 28 due to certain informalities. Claim 6 is amended to refer to "a Ratio Theorem analysis" to provide an introduction of this phrase in claim 6. Claims 24, 25, 27 and 28 are amended to incorporate labels for each of the terms in the equations.

Examiner's Action, Paragraph 3 through Paragraph 5 (first occurrence)

The Examiner rejects claims 1 through 6, 8 and 10 under 35 U.S.C. §103(a) as being unpatentable over United States Letters Patent No. 5,696,646 to Satoh (the "Satoh patent") for a disk apparatus for monitoring error by setting timeout time upon seek and United States Letters Patent No. 5,313,617 to Nakano et al (the "Nakano patent") for a multi-disc optical data storage system for use with a host computer for emulating a magnetic disc device. In summary, the Examiner argues that the Satoh patent discloses a disk system that contains all the elements of each of the claims with the exception of a disk divided into a plurality of volumes each with equal size and reference addresses. However, the Examiner believes that for the advantage of grouping information it would have been

obvious to one of ordinary skill in the art at the time of the invention to divide the disk in the Satoh patent into several volumes each with equal size and reference addresses such as in the Nakano patent, because information which is managed under one volume can be searched and addressed more effectively.

With respect to claims 9 and 19 through 22, the Examiner repeats the rejection under 35 U.S.C. §103(a) as being unpatentable over the Satoh patent in view of the Nakano patent. The Examiner also states that an information storage medium should be partitioned into a plurality of logical volumes with fixed size segments so that addresses can be created accordingly for data allocation.

Applicants respectfully traverse this rejection.

The Satoh patent discloses a disk apparatus which monitors each seek operation to ascertain whether it is completed within a predetermined time window. More specifically, when a seek operation is indicated, apparatus in accordance with the Satoh patent utilizes an arbitrary linear relationship such as shown in FIG. 5 by Graph 64 to obtain a time window value for the specific number of tracks over which the seek operation is to occur. With this operation, a 10-track seek produces the same time window value over any set of 10 adjacent tracks. The

Satoh patent does not calculate the actual seek time. In accordance with the Satoh patent the time window is used only as a control to determine whether an error condition exists. If the seek operation terminates within the time established by the window, the seek operation is deemed to have been completed correctly. Otherwise an error determination is made.

The Nakano patent discloses a data storage system with magnetic and optical disks. A host system receives and transmits commands and data in the format of a magnetic disk. A converter converts the command and data between the format of the magnetic disk and that of the optical disk. An optical disk drive unit and an optical disk transport device are controlled by a command and data in the format of the magnet disk of the host system. If the optical disk memory is to emulate a magnetic disk memory, an address to a specific logical volume in the magnetic disk memory system address space is converted into one of a number of optical disks each of which is assigned a group of contiguous cylinder to track numbers. There is no disclosure or suggestion of any measurement of seek time in the Nakano patent.

Applicants respectfully submit that there is nothing in the Satoh patent that suggests the substitution of any

component or concept in the Nakano patent. These two patents are directed to entirely different concepts. The Satoh patent is directed to monitoring magnetic disk seek times to be sure that seek operations are completed within a time that is dependent upon the length of the seek operation. The Nakano patent is directed to a method of allowing an optical disk system with its unique commands to respond to magnetic disk commands.

Even if it were obvious to combine the teachings of those references, Applicants submit that there are basic differences between the claimed invention and the Satoh patent and that the Nakano patent does not provide the substance of those differences. For example, the Examiner argues that the Satoh patent discloses the establishment of an array of seek times for seek operations between each segment pair based upon first and second boundaries referencing a table 86 in FIG. 7. Table 86 in FIG. 7 includes mathematically determined seek times that represent a linear relationship between the number of tracks over which a seek operation occurs plus some arbitrary time interval. This establishes the maximum time window during which a seek operation of corresponding magnitude should occur.

Claim 1 defines a division of the disk into segments each

having a given size and defined by first and second boundaries. In the Satoh patent the differences are in the number of tracks and not blocks of tracks. Consequently, Applicants believe that the Satoh patent does not disclose segments of the type in the claim because there are no first and second boundaries for a single track. While table 86 contains seek times for different track distances, this is not array of seek times for seek operations between each segment pair based upon the first and second boundaries. In a typical system the boundaries for a segment are the lower and upper addresses for that segment. Applicants further submit that the Satoh patent does not generate a seek time between first and second addresses by interpolating the array based upon the first and second addresses. In the context of the claims the first and second addresses lie within one or more segments. In accordance with this method, the array of seek times based on the first and second boundaries of the segments for starting and ending addresses for the seek operation are then used to generate a disk seek time for that specific operation. As the Nakano patent does not disclose any information about seek times, Applicants believe that these differences remain even if it were appropriate to combine the Satoh and Nakano patents.

Therefore Applicants respectfully submit that claim 1 should be allowed as filed.

Further, the Satoh patent does not perform and interpolation. It uses the first and second addresses to define the number of tracks to be traversed during the seek operation and uses the corresponding entry as the maximum seek time in which this operation will occur if it is successful.

Claim 1 does not require the segments to have equal size. Claim 2 defines a method in which the segment division provides segments of equal size. Nothing in the Satoh patent could suggest equal size because the Satoh patent operates on track-based principles. Therefore Applicants believe claim 2 is also patentable over the Satoh and Nakano patents.

In some situations a starting or ending address for a seek operation could be an index off a segment boundary. Claim 3 defines an embodiment in which that does not occur. That is, the first and second addresses are arbitrary positions on the disk and have no specific relationship to the segment boundaries. Claim 4 further defines each of the first and second addresses as references that are given relative to a predetermined position on the physical disk drive that is separate from the segment boundaries.

Claim 5 further defines the method of claim 1 by stating that the seek time generation uses a linear interpolation based upon the location of the first and second addresses relative to the segment boundaries. This allows the assignment of different seek times for traversing different boundaries. Consequently, in accordance with the invention as set forth in claim 5, it is possible that the seek times assigned for an n-track seek operation may differ if they occur at different physical locations on the disk. In accordance with the Satoh patent it is assumed that the time is constant. Again, this is not a major issue for the system in the Satoh patent that merely establishes a window during which the seek operation should complete successfully. Claim 6 further defines the linear interpolation under a Ratio Theorem analysis. This is a specific version of a linear interpolation. Applicants see nothing in the Satoh or Nakano patents that would suggest the use of such a specific analysis.

Claim 8 defines a data block and an interpolation that uses the boundaries of the data block.

With respect to claim 10, while the Satoh patent arguably discloses a predetermined seek time, namely the fixed window length, Applicants see nothing in the Satoh patent that

constitutes the calculation of intrasegment seek time. Basically, the predetermined seek time in the Satoh patent is the time that is used in the Satoh patent.

With respect to claims 9 and 19 through 22, Applicants believe that nothing in the Satoh patent corresponds to the accumulation of statistics for each access to the logical volume during a time interval. Again, the calculation of a seek time window in accordance with the Satoh patent occurs at the beginning of each seek operation. Nothing in the Satoh patent indicates the accumulation of statistics. Nothing in the Satoh patent discloses or suggests the conversion of such accumulated statistics into an estimated number of seeks between each pair of logical volumes. For the reasons cited above with respect to claims 1 through 8, nothing in the Satoh patent defines seek times for each logical volume pair based upon segment seek times. The Satoh patent merely discloses seek time windows based upon a linear relationship between the number of tracks covered during a seek operation and time. Applicants see nothing in the Satoh patent that constitutes the generation of a total seek time. FIG. 5 is used only for the purpose of determining the window for each seek operation based upon a number of tracks involved in the seek operation for that

specific command. Applicants further submit that nothing in the Nakano patent discloses or suggests any of these differences even if it were appropriate to combine the Satoh patent and Nakano patent disclosures.

Claim 19 defines a step of determining the time for a seek operation within a logical volume. Applicants believe nothing in the Satoh or Nakano patents discloses any such determination of time. Only the time for a window during which the operation should complete is provided in the Satoh patent. There is no discussion of seek times in the Nakano patent.

Applicants see nothing in claims 20 and 21 that discloses or suggests the definition of boundaries of a logical volume and segment boundaries.

Applicants see nothing in the Satoh or Nakano patents that discloses or suggests a step of linearly interpolating seek times determined for seek operations between segments for reasons that have been discussed previously with respect to claims 5 and 6.

Thus, Applicants submit that claims 1 through 6, 8 through 10 and 19 through 22 define methods that are different from methods that are disclosed in the Satoh or Nakano patents taken singly or even if taken in combination. Applicants further

believe that nothing in the Satoh or Nakano patents suggests any interaction between those two patents. Therefore Applicants respectfully submit that the differences between the inventions as set forth in those claims and the disclosures in the Satoh and Nakano patents would not have been obvious to a person of ordinary skill in the art at the time the invention was made.

Examiner's Action, Paragraphs 5 through 7

Applicants acknowledge with appreciation the indication the claims 23 and 26 are allowable, that claims 24, 25, 27 and 28 would be allowable if certain informalities are overcome and that claims 7 and 11 through 18 would be allowable if rewritten in independent form including all the limitations of the base claim and any intervening claims. Applicants have not rewritten claims 7 and 11 through 18 in independent form because Applicants believe that parent claims for each of these claims are allowable.

Examiner's Action, Paragraph 8

Applicants have reviewed the Examiner's statement of reasons for the indication of allowable subject matter. While

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Applicants agree with the definitions in the various sections of paragraph 8, Applicants respectfully request the Examiner to reconsider the reason for allowance based upon Applicants' amendments and arguments herein.

Examiner's Action, Paragraph 9

The Examiner has made other prior art of record, but has not relied upon it. Applicants respectfully submit that nothing in these references taken singly or in combination with each other or in combination with either or the Satoh or Nakano patents disclose Applicants' invention.

Summary

Applicants have amended certain claims in an attempt to more clearly define Applicants' invention. Applicants respectfully request the Examiner to reconsider his objections and rejections in view of these amendments and to allow claims 1 through 28.

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If there are any questions, we urge the Examiner to call us collect.

Respectfully Submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re	:	Eitan Bachmat, Tao Kai Lam and Ruben Michel
Serial No.	:	09/541,159
Filed	:	March 31, 2000
FOR	:	METHOD FOR DETERMINING SEEK TIMES IN A DISK ARRAY STORAGE DEVICE
EXAMINER	:	Kim Kwok Chu
ART UNIT	:	2653

VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification

The paragraph at page 1, lines 2 through 7 has been amended as follows:

This is a continuation-in-part of copending application for United States Letters Patent No. 6,088,766 granted July 11, 2000 (Serial No. 09/002,428 filed January 2, 1998) that is a continuation-in-part of copending application for United States Letters Patent No. 6,061,761 granted May 2, 2000 (Serial No. 08/944,606 filed October 6, 1997) and that is assigned to the same assignee as this invention.

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The paragraph at page 6, lines 1 through 16 has been amended as follows:

Recently more rigorous analyses have been implemented to provide dynamic reallocation based upon actual usage. United States Patent No. 6,189,071 granted February 13, 2001 (Application Serial No. [09/143,613] 09/143,683 filed, August 28, 1998) discloses one such analysis that includes the step of providing an approximation of disk seek times. Generally these approaches determine seek distances and convert the seek distances into time. In more specific terms, this approach uses a statistical analysis by which actual disk accesses are weighted and combined to produce an estimated seek activity. Then this estimate is converted to a seek time by combination with a value, $t_{i,j}$, that is an approximation of the seek time between two logical volumes i and j. However, in some applications it may be desirable to obtain more accurate seek times to use in selecting exchangeable logical volumes that, in turn, can optimize the performance of a disk array storage device.

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The paragraph at page 22, line 13 through page 23, line 3 has been amended as follows:

Step 226 utilizes the resulting number of seeks obtained from Equation (2) and the characteristic seek time from equation (9) to generate the total time for seek operations with the logical volume pair. That is, for a specified logical volume pair i,j, the seek time, *seek time*(i,j) is:

$$Seek\ time\ (i,j)\frac{A_i A_j}{A} = t_{i,j} \qquad (11)$$

Thus [steps220] steps 220 and 226 provide a total seek time over the analysis interval for a logical volume pair (i,j).

The paragraph at page 24, line 21 through page 25, line 2 has been amended as follows:

FIG. 7 depicts a procedure 230 for estimating the seek time for intravolume seek operations in a selected logical volume i. For purposes of explanation and understanding, assume that the LV(2) logical volume shown in FIG. 3 has been selected.

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The paragraph at page 26, line 24 through page 27, line 8 has been amended as follows:

As will become evident, it is only necessary to analyze the [intravolume seek times] intervolume seek times for each logical volume pair. Any number of procedures can be used to avoid duplication. In one approach depicted in FIG. 8, the logical volumes on a physical disk drive are ordered by their position on the drive. For example, the order of the logical volumes in FIG. 3 would be LV1, LV2, LV3. In this particular case the sequence of names corresponds to the order, but the logical volume names and the sequence with which they appear are arbitrary.

In the Claims

6 (Amended). A method as recited in claim 5 wherein said linear interpolation is based upon [the] a Ratio Theorem analysis.

10 (Amended). A method as recited in claim [8] 9 wherein said segment seek time determination includes the step of:

iii) assigning a predetermined seek time for each seek operation between two segment boundaries, and

iv) calculating an intrasegment seek time based upon the predetermined seek times.

23 (Amended). A method for determining the seek time over a time interval for a physical disk drive configured to store data in a plurality of logical volumes, said method comprising the steps of:

A) dividing the physical disk into a plurality of fixed sized segments characterized by boundaries independently of the logical volume configuration on the physical disk drive,

B) determining seek times for seek operations between the segments by assigning empirically derived seek times between two segment boundaries,

C) accumulating statistics for each access to each logical volume during the time interval,

D) converting the accumulated statistics into an estimated number of seeks between each pair of logical volumes by weighting the numbers of accesses in each of different predetermined classes,

E) defining a seek time for each logical volume pair based upon said segment seek times by using the center locations of each logical volume to interpolate the seek times determined for seek operations between the segments, and

F) generating a total seek time that is the sum of the seek times for each logical volume pair obtained as a function of the estimated number of seeks and the defined seek time for the logical volume pair.

24 (Amended). A method as recited in claim 23 wherein each of said center locations is given as an offset from a segment boundary according to:

$$p = x - \lfloor x \rfloor$$

and

$$q = \lceil y \rceil - y$$

where x and y represent center line locations of logical volumes, $\lfloor x \rfloor$ and $\lceil y \rceil$ represent ''floor of x'' and ''ceiling of y'' functions for the values of x and y based upon the boundaries of the segments and p and q represent the displacements of the center line addresses for each logical volume relative to a segment boundary.

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25 (Amended). A method as recited in claim 24 wherein said definition of seek time for each logical volume includes the step of generating a seek time according to:

$$t_{i,j} = pq\ time(\lfloor x \rfloor + 1, \lceil y \rceil - 1)$$

$$+ p(1-q)\ time(\lfloor x \rfloor + 1, \lceil y \rceil)$$

$$+ (1-p)q\ time(\lfloor x \rfloor, \lceil y \rceil - 1)$$

$$+ (1-p)(1-q)\ time(\lfloor x \rfloor, \lceil y \rceil)$$

where $t_{i,j}$ represents the seek time for a specific pair of logical volumes and *time* is the seek interval for the corresponding relationship.

27 (Amended). A method as recited in claim 26 wherein each of the boundary locations is given as an offset from a segment boundary according to:

$$p = x - \lfloor x \rfloor$$

and

$$q = \lceil y \rceil - y$$

where x and y represent center line locations of logical volumes, $\lfloor x \rfloor$ and $\lceil y \rceil$ represent "floor of x" and "ceiling of y" functions for the values of x and y based upon the boundaries of the segments and p and q represent the displacements of the center line addresses for each logical volume relative to a segment boundary.

28 (Amended). A method as recited in claim 27 wherein said definition of seek time for intravolume seeks includes the step of generating a seek time according to:

$$t_{i,j} = pq\ time(\lfloor x \rfloor + 1, \lceil y \rceil - 1)$$

$$+ p(1-q)\ time(\lfloor x \rfloor + 1, \lceil y \rceil)$$

$$+ (1-p)q\ time(\lfloor x \rfloor, \lceil y \rceil - 1)$$

$$+ (1-p)(1-q)\ time(\lfloor x \rfloor, \lceil y \rceil)$$

where t_{ij} represents the seek *time* for a specific pair of logical volumes and time is the seek interval for the corresponding relationship.